

II. REMARKS/ARGUMENTS

A. Remarks regarding amendments to the claims.

Claim 2 has been cancelled. Claims 1, 13, 14, and 15 have been amended to specifically recite that the monolithic flow field-bipolar plate assemblies comprise a first and second porous metal flow field directly bonded to opposite sides of an electrically conducting gas barrier by continuous metallurgical bonds and wherein gaseous reactants are delivered to the intermediate layers by flowing through the pores of the porous metal flow fields. This amendment is supported by original claim 2 and throughout the specification, particularly at p. 17, ll. 15-17. Claims 3-6 have been amended by changing their dependency from claim 2 to claim 1.

B. Double patenting rejection

Claims 1, 5-11, and 13-15 were rejected under the judicially created doctrine of double patenting over claims 1, 2, 5, 6, 8, 9, and 12-14 of co-pending Application Number 09/779,683. Applicants have filed a Terminal Disclaimer, disclaiming the terminal part of the statutory term of any patent granted on the instant application that would extend beyond the expiration date of the full statutory term of any patent granted on pending second Application Number 09/779,683.

C. Rejections under 35 U.S.C. § 103

Claims 1-30 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,372,376, by Fronk et al. (Fronk) and further in view of U.S. Patent No. 6,024,848, by Dufner et al. (Dufner). Specifically, the Examiner alleges that Fronk teaches an electrically conducting fuel cell component comprising a metal flow field, an intermediate layer comprising a plurality of conductive particles dispersed through an acid-resistant polymer matrix, and a protective

layer comprising nickel and other metal oxides. The Examiner states that the intermediate layer of Fronk is bonded to the flow field and that an electrode is bonded to the intermediate layer. The Examiner suggests that Fronk is different from the present claims only in that Fronk does not expressly disclose that the flow field is porous or that the protective layer comprises tin oxide and is 1 to 5 μm thick. The Examiner alleges that Dufner teaches these aspects. Specifically, the Examiner contends that Dufner employs porous plates to decrease the weight of the fuel cell. The Examiner also contends that Dufner teaches that it is well known in the art to employ tin oxide with a thickness of 0.1 to 1 μm to minimize excess accumulation of liquid water at the cathode. According to the Examiner, it would have been obvious to one of ordinary skill in the art to employ the porous flow fields of Dufner in the cell of Fronk to decrease weight of the cell to meet specific operating demands. The Examiner also alleges that it would have been obvious to one of ordinary skill in the art to employ a tin oxide coating on the flow field of Fronk, because Dufner teaches that a tin oxide coating minimizes excess accumulation of liquid water at the cathode. Applicants respectfully traverse.

The present claims and the two cited references concern various aspects of fuel cells. Fuel cell components are depicted in Fig. 1 of the Fronk reference and in Fig. 2 of the Dufner reference. Likewise, Fig. 2 of the instant specification shows a fuel cell comprised of a two fuel cell components that are particular embodiments of instant claim 1.

Fuel cells typically comprise a membrane-electrode assembly (MEA), which often comprises a polymer membrane having electrodes on each side of the membrane. The MEA is denoted as 4 in Fronk, Fig 1. The polymer membrane and the two electrodes are individually denoted as 30, 36, and 38, respectively in Dufner, Fig. 2, and as 7, 6, and 6, respectively in Fig. 2 of the instant specification.

Fuel cells often comprise one or more “intermediate layers” disposed between the MEA and the flow fields. The fuel cell of Fronk comprises carbon diffusion paper 34 and 36 as intermediate layers. Dufner uses the term porous support plates to refer to the intermediate layers, denoted as 40 and 42. In fact, the Dufner reference is primarily focused on the particular support plates (i.e., intermediate layers) described therein. It should be noted that it is known in the art to employ on porous intermediate layers (i.e., porous support layers). *See*, Dufner, col. 2, ll. 44-50. This line in Dufner, which is cited by the Examiner and referred to below, does not concern porous flow fields, but rather, concerns porous intermediate layers. Intermediate layers are denoted as 5 in Fig. 2 of the instant application.

Fuel cells comprise flow fields, which are the structures through which gases are delivered so that they contact the MEA (or contact the intermediate layer(s), through which they diffuse to the MEA). *See*, p. 17, ll. 5-7 of the instant specification. Typical flow fields of the prior art comprise serpentine grooves that are machined into the surface of a solid, conducting plate. *See*, p. 17, ll. 8-10 of the instant specification. Fronk teaches such plates, which are denoted as 8 and 14 in Fig. 1. The serpentine grooves are shown more clearly in the expanded view, Fig. 2, where they are denoted as 66. Dufner also utilizes grooves, denoted as 62 and 68, but refers to the grooves as gas distribution networks. The grooves are cut into plates, 60 and 66, which are referred to as water transport plates.

The instantly claimed invention differs from the two cited references because it does not utilize machined grooves as a flow field, but instead utilizes porous flow fields, wherein the gaseous reactants are delivered to the intermediate layer by flowing through the pores of the porous metal flow fields. Porous metal flow fields utilizing this method of reactant delivery is neither taught nor suggested in either of the cited references.

With these differences between the instant claims and the cited references clarified, it is clear that the cited references do not establish a *prima facie* case that the instant claims are obvious because the cited references do not teach every element of the claimed invention. To support a *prima facie* determination of obviousness, the prior art references must teach every element of the rejected claims. *See*, In re Royka, 490 F.2d 1382, 1385 (CCPA 1970); *see also*, MPEP § 2143.03. Specifically, the cited references do not teach (1) monolithic flow field-bipolar plate assemblies comprising a first and second porous metal flow field directly bonded to opposite sides of an electrically conducting gas barrier by continuous metallurgical bonds, or (2) that gaseous reactants are delivered by flowing through the pores of the porous metal flow field.

1. The cited references do not teach porous metal flow fields.

The Examiner alleges that Fronk teaches flow fields that are metal but that are not porous and Dufner teaches porous flow fields as a means of decreasing weight; so therefore it would be obvious to use porous metal flow fields to decrease the weight of a fuel cell. Applicants respectfully traverse.

(1) Dufner does not actually teach porous flow fields to decrease the weight of the fuel cell. To support her assertion that it does, the Examiner refers to col. 2, ll. 40-50 of Dufner. The cited text of is quoted below:

Therefore the size, weight and related cost of the electrical current generation system must increase substantially only to satisfy transient demands because the fuel cell lacks adequate capacitance to satisfy short-term increased power demands. Fuel cell development has endeavored to enhance fluid transport throughout a cell and to thereby decrease weight and cost requirements to meet specific operating demands. For example, in a typical fuel cell the anode and cathode electrodes comprise thin, porous catalyst layers supported by porous support layers in intimate contact with opposed major surfaces of an electrolyte such as a PEM. (*emphasis added*)

This cited text does not say anything at all about porous flow fields. Rather, it refers to porous catalyst layers and porous support layers, which are indeed known in the art. The Dufner reference does not suggest porous flow fields to decrease the weight of the cell.

Applicants note that Dufner does mention porous water transport plates, which are denoted 60 and 66 in Fig. 2. *See*, Dufner, col. 8, l. 66 – col. 9, l. 4. The water transport plates allow water produced at the MEA to transfer through the plates and collect at water feed channels 64A, 64B, 64C, 70A, 70B, and 70C. *See*, Dufner, col. 5, ll. 52-67. Dufner states that these plates are porous and preferably made of a carbon-carbon composite of graphite powder phenolic resins. They are not made of porous metal. Because the stated purpose of these plates is to transport water, there is no motivation to substitute porous metal instead of the carbon-carbon composite of graphite powder phenolic resins, because it is unlikely that these materials would have similar water transport properties, i.e., similar hydrophilicities.

(2) The combination of serpentine grooved flow fields in metal plates combined with serpentine grooved flow fields in porous carbon-carbon composite plates does not teach or suggest porous metal flow fields that do not require serpentine grooves. Firstly, both referenced flow fields utilize grooves, rather than gas flow through pores. Secondly, porous metal is a different material with different properties than either solid metal or porous resin.

2. The cited references do not teach that gaseous reactants are delivered by flowing through the pores of the porous metal flow field.

Claims 1, 13, 14, and 15 have been amended to more distinctly point out that in fuel cell components of the present invention, gaseous reactants are delivered by flowing through the pores of the porous metal flow field. Neither the Fronk nor the Dufner references teach or suggest this element. There is no suggestion in the Dufner reference because the plate of Dufner is capable of performing the same function. In fact, it is not apparent from the Dufner reference that the water

Serial No.: 09/779,872

Page 13 of 17

transport plates of Dufner are capable of effectively delivering gaseous reactants by having the gaseous reactant flow through the pores. For example, Dufner teaches:

The first and second water transport plates 60, 66 are also porous and preferably a carbon-carbon composite made from graphite powder phenolic resins by methods well-known to those skilled in the art, wherein the water transport plates 60, 66 have a mean pore diameter of 1-3 microns and a pore volume of about 25-40 per cent.

See, Dufner, col. 8, l. 66 - col. 9, l. 4.

In contrast, the mean pore diameter and pore volume of the porous metal flow fields instant claims are not so limited. For example, the present specification teaches that the method of preparing the porous metal structure used for the flow field is described in U.S. Patent No. 4, 882,232, which is incorporated into the specification by reference. A copy of U.S. Patent No. 4, 882,232 is attached to the present paper as **Exhibit A**. U.S. Patent No. 4,882,232 teaches porous metal structures that have open-pore volumes as high as 80%-98%. See, U.S. Patent No. 4,882,232, col. 3, ll. 40-43. This teaching of the instant specification is not intended to limit the scope of the present claims to any particular open-pore volume, but is intended to demonstrate that the porous metal flow fields of the present claims are facially different than the carbon composite plates of the Dufner reference. The present specification enables a fuel cell component, wherein gaseous reactants are delivered via diffusion through the pores of a porous metal flow field. The Examiner has alleged that the plates of Dufner, which comprise a different porous material with different properties, would be suitable for the same function. But the Examiner has not provided any evidence to support her allegation and therefore has not met her burden for establishing a *prima facie* case of obviousness.

The fact that the plates taught by Dufner are designed to cooperate with their neighbors to provide water transport channels and are therefore not separated by barriers is a further indication

Serial No.: 09/779,872

Page 14 of 17

that gaseous reactants do not flow through the pores in the plates of Dufner. One of skill in the art will appreciate that when cells are aligned in a fuel cell stack, the cathodic side of one cell butts up against the anodic side of the neighboring cell, just like when batteries are put into a flashlight. In other words, they are installed in series, //+/- // //+/- // etc.... In fuel cells, a reducing gas is delivered to the anode side of the fuel cell, while an oxidizing gas is delivered to the cathode side of the fuel cell. If the gases were allowed to flow freely through the pores of the Dufner plates, then the oxidizing gas of the cathode of one fuel cell would flow into the anode of the neighboring cell, which would cause the cell stack to malfunction. It is apparent from the Dufner reference that there is no barrier to prevent this from happening because Dufner teaches that the water transport plates “are dimensioned to cooperate with water transport plates of adjacent fuel cells (not shown), in a manner well-known in the art wherein the feed water channels of adjacent water transport plates define tunnel-like channels whenever the plates are positioned adjacent each other.” *See*, Dufner, col. 5. ll. 62-67. If the water feed channels 64A, 64B, 64C, butt up against water feed channels of the neighboring cell to define tunnels, then the cells are clearly not separated by a gas barrier. It is therefore clear that the plates of Dufner are not configured to carry gas to the intermediate layer by allowing the gaseous reactants to flow through the pores, because having gaseous reactants flow through the pores would cause the stack to malfunction. Rather, it is clear that the gaseous reactants flow through the gas distribution network, which is specifically designed for that purpose, and are not delivered via flowing through the pores.

Even if the plates of Dufner are suitable for delivering gaseous reactants to the MEA, this still is not the proper basis for rejecting the instant claims under 35 U.S.C. § 103 because doing so requires a change in the principle of operation of the Dufner plates, which is impermissible. *See*, MPEP § 2143.01. The principle of operation of the plates of Dufner is to deliver gaseous

reactants via the gas distribution network, i.e., through mechanically cut grooves. This is precisely the principle of operation that the present invention is designed to eliminate. *See*, p. 17, ll. 15-17 of the present specification. Both the Fronk and Dufner references teach gas delivery through mechanically cut grooves as the mode of operation. There is no motivation in either reference to change this mode of operation by delivering gaseous reactants via diffusion through a porous metal flow field.

3. The cited references do not teach a porous metal flow field coated with a protective layer of tin oxide.

The Examiner also alleges that it would have been obvious to employ tin oxide on the flow field of Fronk because Dufner teaches that tin oxide minimizes excess accumulation of liquid water at the cathode. Specifically, the Examiner points to col. 8, ll. 45-50 of Dufner. This text refers to treating the substrate layer (i.e., the intermediate layer) with tin oxide, which acts as a wettability-preserving compound, i.e., a hydrophilic compound, to counteract the effect that carbon structures within the PEM become hydrophobic over time. *See*, Dufner col. 8, ll. 30-45. The passage cited by the Examiner does not teach applying tin oxide to the flow field; it has nothing to do with treating the flow field.

Likewise, the Examiner cites col. 7, ll. 45-65, alleging that this passage teaches a tin oxide layer having a thickness of 0.1 to 1.0 μm . In fact, these dimensions refer to the mean pore diameter of the contact bi-layers (i.e., a particular region of the intermediate layer). This dimension is not referring to the thickness of a tin oxide layer.

Further, applying tin oxide to a flow field of Fronk still would not arrive at the presently claimed invention because the flow field of Fronk is not a porous metal flow field. As described above, neither Fronk nor Dufner teach porous metal flow fields. Because the references do not

teach every element of the present claims, Applicants respectfully request that the rejections under 35 U.S.C. § 103 be withdrawn.

The cited references do not establish a *prima facie* case that the instant claims are obvious because the cited references do not teach every element of the claimed invention. To support a *prima facie* determination of obviousness, the prior art references must teach every element of the rejected claims. *See*, In re Royka, 490 F.2d 1382, 1385 (CCPA 1970); *see also*, MPEP § 2143.03. Specifically, the cited references do not teach (1) monolithic flow field-bipolar plate assemblies comprising a first and second porous metal flow field directly bonded to opposite sides of an electrically conducting gas barrier by continuous metallurgical bonds, or (2) that gaseous reactants are delivered by flowing through the pores of the porous metal flow field.

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The Examiner is invited to contact the undersigned patent agent at 713-787-1558 with any questions, comments or suggestions relating to the referenced patent application.

Respectfully submitted,



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